National Aeronautics and Space Administration

Sensors

Fluid Measurement Sensor

A wireless, powerless, passive inductor-capacitor sensor for measuring fluid level, pitch and roll angles, and volume

NASA's Langley Research Center researchers have developed a wireless, thin-film fluid measurement sensor that uses a magnetic field response measurement acquisition system to provide power to the sensor and to acquire physical property measurements from it. In addition to measuring fluids within an enclosed container, it can be placed external to a non-conductive container to measure the level of any non-gaseous substance, including liquids, solids, and semi-solids such as powder or granular substances.

BENEFITS

- Receives power wirelessly, eliminating the need for a sensor power source
- Sends signals wirelessly to the data acquisition device, eliminating signal wiring
- Reduces system weight due to less wiring
- Non-mechanical method for fluid measurement - no moving parts, reducing the probability of failure
- Eliminates potential for arcing (safer use in fuel tanks)
- Lightweight
- Can measure fuels without opening the tank, reducing emission of harmful gases

technology solution

THE TECHNOLOGY

The fluid measurement sensor is configured with a spiral electrical trace on flexible substrate. The sensor receives a signal from the accompanying magnetic field data acquisition system. Once electrically active, the sensor produces its own harmonic magnetic field as the inductor stores and releases magnetic energy. The antenna of the measurement acquisition system is switched from transmitting to receiving mode to acquire the magnetic-field response of the sensor. The magnetic-field response attributes of frequency, amplitude, and bandwidth of the inductor correspond to the physical property states measured by the sensor. The received response is correlated to calibrated data to determine the physical property measurement. When multiple sensors are inductively coupled, the data acquisition system only needs to activate and read one sensor to obtain measurement data from all of them.

Fluid level measurement occurs in several ways. In the immersion method, the capacitance of the sensor circuit changes as it is immersed in fluid, thus changing the frequency response as the fluid level rises or falls. Fluid level can also be measured from the outside of a non-conductive container. The response frequency from the sensor is dependent upon the inductance of the container plus the combination of fluid and air inside it, which corresponds to the level of liquid inside the container. Roll and pitch are measured by using three or more sensors in a container. With any given orientation, each sensor will detect a different fluid level, thus providing the basis for calculating the fluid angle. Volume can be measured in the same way, using the angle levels detected by the sensors and the geometric characteristics of the container to perform the volume calculation.

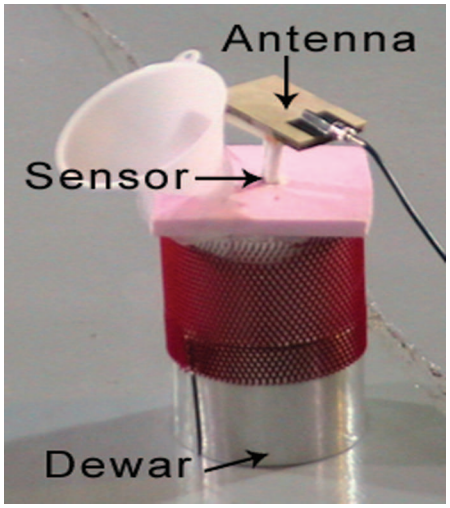

FIGURE 2: Magnetic field response fluid-level sensor immersed in liquid nitrogen

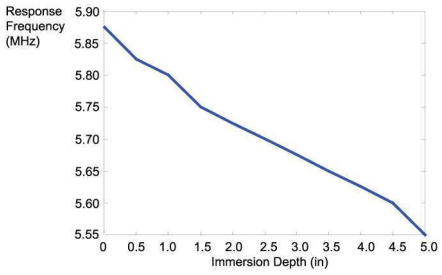

FIGURE 3: Mesurement of cryogen level (LN2)using wireless fluid-level sensor

APPLICATIONS

The technology has several potential applications:

- Fuel and other liquid measurements in vehicles
- Above or below ground fuel storage tanks
- Cryogenic fluid tanks

PUBLICATIONS

Patent No: 7,814,786; 7,255,004; 7,506,541; 7,711,509; 7,902,815

More Information

National Aeronautics and Space Administration

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